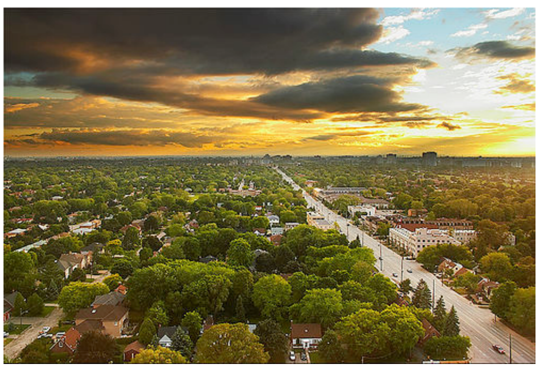
April 2021

Reading - Social and Biophysical Drivers of Urban Ecosystems

Center for Urban Resilience

Module 2 – Lesson 2: The Social and *Biophysical Drivers of Urban Ecosystems:*

As you know by now, cities are complicated landscapes. Humans and many other species of living organisms live in high density. Resources are limited for everybody – humans, animals and plants, alike. Ecologists think of cities as human-dominated ecosystems. The picture below, taken in Toronto, gives you a sense of just how integrated humans and other organisms are in city landscapes. The trees and buildings are intermixed into a mosaic that is the urban ecosystem.



We also understand that the trees and buildings were put there by the people who built Toronto. Before the city was built, the ecosystem looked very different. As such, the ecosystem has changed over time and will continue to change as the forces of nature and humans shape the landscape. Toronto, and all the world's ecosystems, are in a constant state of change.

The challenge of making cites healthy and sustainable is to discover the forces or drivers that change urban ecosystems over time. Urban ecologists recognize two main types of drivers that change the ecology of cities. The first category of drivers is biogeophysical. These are what we might call "natural" forces such as sunlight energy, climate, biodiversity, the movement of chemicals and the fluctuations in animal and plant populations. These drivers have been studied for over two centuries by ecologists and are how they generally characterize ecosystems. For example, deserts ecosystems are hot and dry because they receive lots of sunlight energy, very little rainfall, have poor soils because the chemicals are bound up in rocks and relatively low biodiversity. In contrast, tropical rainforests are wet and lush because they also receive lots of sunlight, but also plenty of rain. Their biodiversity is very high and the critical chemicals in rain forests are found in the living organisms, mostly in the trees.

This type of analysis works well for ecosystems that have very few humans. However, when we consider the ecology of cities, we must also consider the enormous impact human behavior has on the ecosystem. Therefore, urban ecologists consider an additional category of drivers called socioeconomic. These are the forces that are exerted by humans through their cultural beliefs, political ideologies and behavior practices. These socioeconomic forces are just as important as the biogeophysical ones in urban ecosystems.

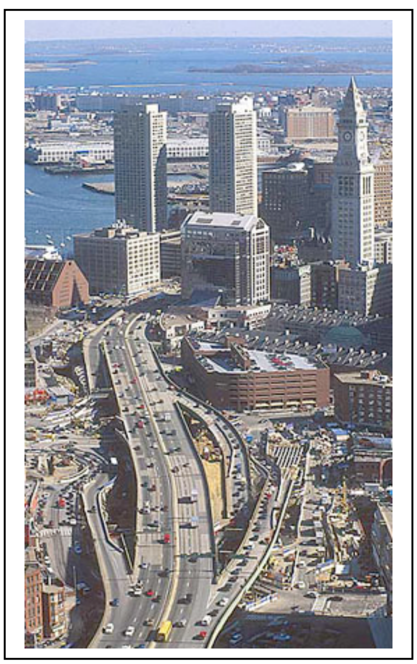
Take for example, urban rivers. Before humans settled a city, the rivers that flowed through the ecosystem were most likely clean supporting a wide variety of fish and plants. As humans built factories along the river, the ecosystem became degraded. Ecologists can measure the biogeophysical changes. But to fully understand the ecology of an urban river, the scientists must also know the human history and the socioeconomic drivers that altered the river.

For example, most of the factories that line the rivers of American cities no longer need the river for power or transportation. Many of those factories are no longer even used. As a result, river revitalization programs have been started to clean the river ecosystems and turn the factories into sustainable human housing. These projects required knowledge and balance between both the biogeophysical and socioeconomic drivers of the city.

Closer to Home Boston Metropolitan Area: *The Big Dig Changes the Ecology of Boston*

If you live in, or near Boston, your life has been changed by the results of the Big Dig. Formally known as the *Central Artery Project*, the human scale of this undertaking was similar to building the Panama Canal or the Hoover Dam. The project reconfigured the highways of downtown Boston that carry nearly 200,000 cars each day. To understand the impact of this project on the ecology of Boston, we need to investigate the biogeophysical and socioeconomic drivers that lead to the Big Dig.

The original highway system in Boston was built in 1959 and was designed to handle about 75,000 cars each day. As you can see from the picture below, it was built above ground. It cut off neighborhoods and displaced nearly 20,000 residents. Before long, the highway was inadequate for the level of traffic that it was handling. Traffic slowed to a crawl for 10 hours daily.



The combined effects of the traffic snarl were an economic and environmental disaster. Extra pollution and gas use was created from idling cars stuck in traffic. Lost productivity was estimated at $500 million annually. The ecology of Boston suffered from the impacts.

In response to these challenges, a plan was developed by the Massachusetts Turnpike Authority to put an 8-10 lane highway underground and create 260 acres of public parklands where the old above ground highway used to be. The project required nearly ten years to complete and spanned eight miles of highway. Two bridge systems and a new tunnel were built. Four million cubic yards of concrete were used and enough earth was removed to build a new island in Boston Harbor. The crowning achievement of the project is the Zakim Bunker Hill Bridge, which is the widest cable stay bridge in the world (see below).

A project of this size has enormous physical and social impacts on the ecosystem of the city. A scientist who studies urban ecology needs to consider the history, the social factors and the physical impacts of such a project on the landscape. Boston changed as a result of the Big Dig. The ecology of the city has improved in many ways. The drivers of these changes are both biogeophyscial and socioeconomic. To consider only one group of forces would cause you to uncover only half the story.

More information on the Central Artery Project can be found on the Turnpike Authority website:

www.masspike.com/bigdig/